January 7, 2005

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 70-3103
LOUISIANA ENERGY SERVICES, L.P.	)	
	)	ASLBP No. 04-826-01-ML
(National Enrichment Facility)	)	

NRC STAFF TESTIMONY OF ALAN TOBLIN CONCERNING
NUCLEAR INFORMATION AND RESEARCH SERVICE AND PUBLIC CITIZEN
ENVIRONMENTAL CONTENTION 2 ("NIRS/PC EC-2")
(IMPACTS UPON WATER SUPPLIES)

Q1. Please state your name, occupation, and by whom you are employed.

A1. My name is Alan Toblin. I am employed as a consultant with Advanced Technologies and Laboratories International, Inc. ("ATL") in Germantown, Maryland. I am providing this testimony under a technical assistance contract between the staff of the Nuclear Regulatory Commission ("NRC Staff" or "Staff") and ATL. A statement of my professional qualifications is attached hereto.

Q2. Please describe your current responsibilities.

A2. I am currently performing work on the groundwater transport of contaminants and on the health consequence risk of chemical and radiological releases from potential accidents at nuclear facilities.

Q3. Please explain what your duties have been in connection with the NRC Staff's review of Louisiana Energy Services, L.P.'s ("LES") application to construct, operate and decommission a gas centrifuge uranium enrichment facility near Eunice, New Mexico.

A3. As part of my official responsibilities, I assisted the NRC Staff in its evaluation of the potential environmental impacts related to LES' construction, operation, and decommissioning of a gas centrifuge uranium enrichment facility near Eunice, New Mexico.

My specific role was to conduct an evaluation of potential impacts to ground and surface water and water supplies due to construction, operation and decommissioning of that proposed facility. Further, I assisted in preparation of the Staff's *Draft Environmental Impact Statement for the Proposed National Enrichment Facility in Lea County, New Mexico*, NUREG-1790, issued September 2004, ("DEIS" attached as Exhibit 1). I also assisted the NRC Staff in preparing portions of the "NRC Staff's Response to Interrogatories and Document Request by Petitioners Nuclear Information and Resource Service and Public Citizen to Commission Staff," dated November 10, 2004.

Q4. What is the purpose of this testimony?

A4. The purpose of this testimony is to provide the NRC Staff's views concerning NIRS/PC EC-2 specifically regarding the NRC Staff's evaluation of how pumpage from the proposed National Enrichment Facility ("NEF") would affect water levels and the long-term productivity of the Hobbs well field or the Lea County Underground Water basin.

Q5. Are you familiar with NIRS/PC EC-2?

A5. Yes. I understand that NIRS/PC EC-2, as admitted by the Licensing Board in its Memorandum and Order (Initial Prehearing Order) of April 15, 2004, and modified by the Licensing Board's Memorandum and Order (Ruling on Late-Filed Contentions) of November 22, 2004, states as follows:

> Petitioners contend that the Environmental Report (ER) contained in the application does not contain a complete or adequate assessment of the potential environmental impacts of the proposed project upon water supplies in the area of the project, contrary to 10 C.F.R. 51.45.
>
> To introduce a new industrial facility with significant water needs in an area with a projected water shortage runs counter to the federal responsibility to act "as a trustee of the environment for succeeding generations," according to the National Environmental Policy Act § 101(b)(1) and 55 U.S.C. § 4331(b)(1). To present a full statement of the costs and benefits of the proposed facility the ER should set forth the impacts of the National Enrichment Facility on

groundwater supplies.

> The DEIS does compare the water use of the proposed facility to the amount of water stored in the Ogallala Aquifer in the entire State of New Mexico (DEIS at 4-15). However, NRC has not shown in the DEIS how this pumpage would affect water levels and the long-term productivity of the Hobbs well field or the Lea County Underground Water Basin.

Q6. What are the Ogallala Aquifer, the Lea County Underground Water Basin, and the Hobbs well field?

A6. The Ogallala Aquifer is a huge underground reservoir created millions of years ago that supplies water to the region which includes the proposed NEF site. The aquifer extends under the High Plains from west of the Mississippi River to east of the Rocky Mountains. The aquifer system underlies 450,000 square kilometers (174,000 square miles) in parts of eight states (Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming) and approximately 1.5% of its water (60 billion cubic meters, or 16 trillion gallons) is located under New Mexico. Section 3.8.2.1 of the DEIS, found at page 3-37, provides further details on the Ogallala aquifer.

The Lea County Underground Water Basin is the portion of the Ogallala Aquifer that lies within Lea County. The ground water withdrawal in Lea County in 1995 was approximately 600,000 cubic meters (160 million gallons) per day, the majority of which was from the Lea County Underground Water Basin. (*Lea County Regional Water Plan*, Executive Summary, December 2000, at p. 1, available at: http://www.seo.state.nm.us/water-info/NMWaterPlanning/regions/leacounty/leacnty-menu.html, attached as Exhibit 2).

The Hobbs well field is located within the Lea County Underground Water Basin. The well field is north of the city of Hobbs and consists of a set of wells that supply water to the Hobbs and Eunice municipal systems. The Eunice and Hobbs municipal water-

supply systems have capacities of 16,350 cubic meters per day (4.32 million gallons per day) and 75,700 cubic meters per day (20 million gallons per day), respectively. (DEIS, at p. 3-39). The combined current usage of both municipal systems is 35,280 cubic meters (9.32 million gallons) per day. (DEIS, at p. 3-39, sum of Eunice and Hobbs current usage).

Q7. In determining the environmental impacts from the construction, operation, and decommissioning of the proposed NEF, is it important to assess the potential impacts to water supplies?

A7. Yes. It is important to assess the potential impacts to water supplies in determining the environmental impacts from the proposed NEF because there is a heavy reliance on the Ogallala Aquifer for local and regional uses (e.g. drinking water, irrigation, and industrial uses). Withdrawals from the Aquifer exceed recharge to it, and so the Ogallala Aquifer is considered a nonrenewable water source. (DEIS, at p. 3-37). The effects of the NEF water use on the limited local and regional supplies is, therefore, of environmental concern.

Q8. On behalf of the NRC Staff, have you conducted an evaluation of the potential impacts to water supplies resulting from the construction, operation, and decommissioning of the proposed NEF?

A8. Yes. I conducted an evaluation of these matters, which is set forth in various sections of the DEIS issued in September 2004. In particular, the impacts of the proposed NEF on water supplies in and around the proposed Lea County site are discussed in DEIS §§ 3.8.2.1, 3.8.2.2, 4.2.6.3, 4.2.6.4, 4.3.6, and 4.4.3.

Q9. On behalf of the NRC Staff, have you reached a conclusion as to the potential impacts that may result from construction, operation, and decommissioning of the proposed NEF on water supplies?

A9. Yes. As set forth in sections 4.2.6.3, 4.3.6, and 4.4.3 of the DEIS, I have evaluated the potential impacts due to construction, operation, and decommissioning of the proposed NEF

on water supplies in Lea County, and have determined that any such impacts will be small.

Q10. Through what analysis did you reach the conclusion that impacts to water supplies in Lea County from the proposed NEF would be small?

A10. In concluding that the impacts to water supplies in Lea County from the proposed NEF would be small, I compared the projected NEF water use with the capacity of the municipal supply systems of Eunice and Hobbs, NM, from which water rights for the proposed NEF would be obtained. I found that the average water use by the proposed facility would amount to only 0.26 percent of the combined capacity of these municipal systems. Furthermore, I compared the total projected NEF water use over the life of the facility with reserves of the Ogallala Aquifer. I found that the proposed NEF would use only 0.004 percent of the Ogallala Aquifer reserves within the State of New Mexico. I therefore concluded that the impacts of the NEF to local and regional water supplies would be small. (DEIS, at pp. 4-14, 4-15).

Q11. Have you considered how pumpage for the proposed NEF would affect water levels and the long-term productivity of the Hobbs well field or the Lea County Underground Water Basin?

A11. Yes, I used the finite-difference numerical computer model of the Lea County Underground Water Basin to determine the effects that water withdrawal for the proposed NEF would have on water levels and the long-term productivity of the Hobbs well field and the Lea County Underground Water Basin, provided by the New Mexico Office of the State Engineer. (Musharrafieh, G. & Chudnoff, M., *Numerical Simulation of Groundwater Flow for Water Rights Administration in the Lea County Underground Water Basin New Mexico*, New Mexico Office of the State Engineer, Hydrology Bureau Report 99-1, January 1999, attached as Exhibit 3).

The model contains parameters determined by the State based on historical water levels within the basin from 1948 to 1996. These parameters were hydraulic conductivity,

evapotranspiration, and recharge rate. Respectively, these parameters govern the rates at which water flows within, is removed from, and is added naturally to the modeled area of the aquifer. The State then used this model to estimate the effect of continued withdrawals on water levels in the Lea County Underground Water Basin to the year 2040. In my analysis, I applied all model assumptions and parameters that were determined by the State. Using the input files supplied by the State, I ran the model and reproduced the 1996 and 2040 results for drawdown and saturated water depth given in the State's report.

I then modeled the additional water withdrawal specifically from the Hobbs well field attributed to usage by the proposed NEF for 2010 to 2040. This was done by using the same model as described above, but changing the input to reflect the increased water withdrawal specifically from the area north of the city of Hobbs by the projected NEF water usage.

Q12. As a result of running the numerical computer model described in A11 above, what did you find to be the drawdown impacts of the proposed NEF on the Hobbs well field and Lea County Underground Water Basin?

A12. Model results showed that 30 years of water withdrawn for NEF use would result in 1.2 feet of additional drawdown locally at the Hobbs well field. This drawdown would decrease with distance so that at approximately 1 and 2 miles from the withdrawal location, the additional drawdown would be 0.4 feet and less than 0.1 feet, respectively, after 30 years.

Q13. Do you consider this amount of drawdown to be a significant impact on long-term water supplies of Lea County?

A13. No. This amount of drawdown would result in a small impact on the long-term water supplies of Lea County. This can be demonstrated by comparing the drawdown to the remaining saturated thickness at Hobbs in the year 2040. After accounting for NEF water use, the saturated thickness at Hobbs is approximately 37 feet, as compared to the 38.2

feet that would exist in the absence of any NEF water usage.

Q14. Does this conclude your testimony?

A14. Yes.

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EDUCATION: M.S., Chemical Engineering, University of Maryland, 1970
B.E., Chemical Engineering, Cooper Union, 1968
Course work and qualifying exam completed for PhD in Chemical Engineering, University of Maryland, 1970-72

EXPERIENCE SUMMARY:

Mr. Toblin has 32+ years of professional experience as a Principal Investigator and Technical Manager for analyses of contaminant (chemical, radionuclide, thermal) transport in groundwater, surface water and air environments. He has performed such analyses for numerous major industrial sites and government agencies, including all major DOE sites, in support of construction, operations, and clean-up activities. He has defended such analyses as an expert witness in state and federal hearing processes. Mr. Toblin also performs probabilistic risk assessments in support of licensing and operations of power plants and other facilities.

PROJECT EXPERIENCE:

Analyst; Determine Water Resources Impacts for the Proposed National Enrichment Facility; NRC (ATL Inc.); Lea County, New Mexico; Evaluated potential impacts to ground and surface water and water supplies due to construction, operation and decommissioning of that proposed facility. Prepared corresponding sections of the Draft Environmental Impact Statement.

Analyst; Determine Water Quality Impacts and Human Health Risks for Decontamination and Decommissioning of Sequoyah Fuels Corp; NRC (ATL Inc.); Gore, Ok.; Reviewed site analyses of water quality (chiefly groundwater) and human health impacts (ingestion, inhalation, external radiation) for site decommissioning. Performed independent analyses of future groundwater impacts on the site, at the site boundary and offsite. (Draft) Environmental impact statement written.

Analyst; Hazardous Waste Cap Performance for Operating Unit 3; Portsmouth Naval Yard; Portsmouth, N.H.; Evaluated water budget for the hazardous waste site for no action, and with various cap options. Determined flow through the cap to the groundwater using HELP3 model.

Analyst; Hydrologic Transport from Saltstone Disposition; DOE; Savannah River; Evaluated groundwater and subsequent surface water transport of contaminants from the proposed saltstone vaults. Transport included unsaturated flow, saturated flow, and impacts on local creeks.

Analyst; High Level Waste Tank Closure in F and H Areas; U.S. DOE; Savannah River Site; Performed groundwater modeling in support of closure of high level waste tanks in F and H areas at Savannah River Site. Performed for tank farm and specific tank closure plans and EIS. Analysis includes concentration profiles at hypothetical 1-meter and 100-meter wells plus groundwater discharge points.

Analyst; River Water System EIS; U.S. DOE; Savannah River Site;. Performed groundwater quality and quantity modeling of the impacts of changing flows through Savannah River Site, including draining of L-Lake.

Task Leader; Sandia Sitewide EIS; U.S. DOE; Albuquerque, NM; Performed groundwater and surface water modeling of the water quality and quantity impacts of Sandia (Albuquerque) Sitewide operations.

Analyst; Yucca Mountain EIS; U.S. DOE; Las Vegas, NV; Performed radiological dose analyses for the no action alternative to the proposed disposal of material at Yucca Mountain. Atmospheric, surface water, and groundwater modeling analyses of the effects of leaving high level waste and spent fuel in place at each of the U.S. nuclear power plants and at DOE sites.

Analyst; Interim Management of Nuclear Materials EIS; F-Canyon Plutonium Solutions EIS; U.S. DOE; Savannah River; Performed analyses of radiological and chemical releases to hydrosphere for various source materials and processing options. Calculated doses to public from releases. Authored water resources sections of EIS.

Task Leader; Waste Management EIS; U.S. DOE; Savannah River; Determined radiological and chemical concentrations and drinking water doses as a result of releases from below grade vaults and slit trenches. Applied and modified the results from the Radiological Performance Assessment so that they were appropriate for the specific EIS options.

Task Leader; Critical Review of RESRAD Computer Code; Argonne National Laboratory; Argonne, Ill; Performed in-depth review of regulations, theory, coding, and results of code to implement DOE policy for reducing Residual Radioactive (RESRAD) material to levels as low as reasonably achievable (ALARA) on a site-specific basis. Emphasized environmental transport (air, groundwater, surface run-off). Suggestions to improve code's applications and fix errors found were implemented by code's authors.

Technical Manager; Waste Management Activities For Groundwater Protection at the Savannah River Plant EIS; U.S. DOE; Savannah River; Technical Manager for analyzing the contaminant transport and human health effects from the burial of low-level waste at DOE sites. Determined allowable disposal concentrations such that all DOE/NRC/EPA/State regulations regarding radiation exposure would be met at the time of emplacement and in the future. Authored EIS sections.

Technical Manager; Groundwater Contamination Remediation; Sherwin Williams; Directed three dimensional finite element groundwater modeling analysis which simulated the past release to and subsequent movement of material in a multi-aquifer system. A conceptual model was formulated and the flow (3D-FEMWATER) and transport (3D-LEWASTE) models used to deduce the release scenario from the present state of the plumes. Predictions of the temporal and spatial fate of the plumes, assuming no interdiction, lead to use of the model to develop a strategy for remediating the groundwater contamination.

Technical Manager; Resource Conservation and Recovery Act, Subpart X permitting at U.S. Army Open Burning and Open Detonation units; Martin Marietta; Directed technical group which performed multimedia hazardous material environmental transport modeling in air, groundwater, and surface water in support of RCRA Subpart X.

Analyst; Accelerator Production of Tritium EIS; U.S. DOE; Performed surface and groundwater impact analyses for Accelerator Production of Tritium.

Analyst; Remedial Investigation and Feasibility Study of Dahlgren Naval Base; U.S Department of Defense; Portsmouth, Virginia; Computer modeling of the impacts of remediation alternatives on groundwater and surface water quality and quantity for sites 9, 10, 17, 19, 25 and 29.

Analyst: Accident Environment for Proposed Pluto Space Shot: Determined accident environments (fragment velocity, position, pressure from explosions, etc.) for space shot from 2 proposed rocket systems.

Analyst: Modern Pit Facility Environmental Impact Statement: Performed accident analyses of proposed facility at 5 sites. Determined dose to non-involved worker, MEI and population. Produced isodose maps for each site.

Analyst; Site-wide Environmental Impact Statement for Lawrence Livermore National Laboratory; Performed accident analyses for non-involved and involved workers, MEI and population for all site facilities existing and proposed. Performed dose and health impact analyses from normal radioactive releases (ground water, atmospheric) to MEI and population from existing and proposed facilities.

Analyst; Level 3 Probabilistic Risk Assessment of Joseph M. Farley Nuclear Plant, Southern Nuclear Company; Performed PRA including source term derivation, analysis of meteorology/climatology data, local economic and agricultural production, evacuation simulation. Radiological dose, economic costs and risk calculated for hypothetical risk-important accidents.

Analyst; Level 3 Probabilistic Risk Assessment of V.C. Summer Nuclear Station, South Carolina Electric & Gas; H.B. Robinson Nuclear Station, Carolina Power & Light; Performed PRA including source term derivation, analysis of meteorology/climatology data,

local economic and agricultural production, evacuation simulation. Radiological dose, economic costs and risk calculated for hypothetical risk-important accidents.

Analyst; Temperature Distribution in Atlantic Ocean from Uprated Brunswick Steam Electric Plant; Carolina Power and Light Company; Southport, NC; Statistical analysis of muti-year thermal monitoring data to determine isotherm areas and extents. Operations data scaled to account for increased heat load of proposed uprate. Scaling included heat load and buoyancy effects.

Task Leader; Develop Radiological Accident Response Code; Mallinckrodt; St.Louis, Mo.; Developed atmospheric transport and dose calculation computational model, based on Rascal kernel, directly applicable to client's site. Model is simple to use, contains all of the site-specific parameters, and calculates doses in the event of various accident scenarios at specific special receptors.

Task Leader; Review of Ultimate Heat Sink Technical Specification Change; NRC (Scientech Corp.); Hartsville, S.C.; Evaluated utility's application with regard to changing their method of operating their ultimate heat sink (cooling pond). Reviewed supporting material and suggested revisions to the application.

Task Leader; Level 3 Probabilistic Risk Assessment of Hatch NPP; Southern Nuclear Operating Company; Baxley, Georgia; Performed PRA including source term derivation, analysis of meteorology/climatology data, local economic and agricultural production, evacuation simulation. Radiological dose, economic costs and risk calculated for hypothetical risk-important accidents.

Task Leader; Review of Hazard and Operability Study of Ross Incineration Services; U.S. Environmental Protection Agency; Cleveland, Ohio; Reviewed Failure Mode and Effects Analysis. Comments regarding hazards analyzed and actions taken supplied to EPA.

Task Leader; Modeling of the thermal response of the service water pond at V.C. Summer Station NPP to upgrades in station operation; South Carolina Electric and Gas Corp; Columbia, S.C.; Modeled 30 years of sequential 3D pond temperatures for comparison with technical specification limits on temperature rise through the pond. The transient response of the pond to varying pond elevation, plant operation and meteorology was performed. A 30 day period of measured pond temperatures were simulated with the model and found to be an excellent match.

Task Leader; Accident Consequence Analysis (Level 3 PRA); Scientech Corp (U.S. NRC); Rockville, MD; Co-instructor of course presented to USNRC personnel. Course covered source terms, dispersion, health effects and health models, protective measures, and economic consequences.

Analyst; Reconfiguration (Stockpile Stewardship and Management, Highly Enriched Uranium, Fissile Material Development, Storage and Disposition, Tritium Supply and Recycling EISs); U.S. DOE; Washington, D.C.; Performed accident risk analyses (radiological

and chemical) in support of DOE reconfiguration.

Task Manager; Programmatic Spent Nuclear Fuel Management EIS; U.S. DOE; Idaho Falls, Id; Technical direction of group performing Occupational and Public Health and Safety sections dealing with use of the Oak Ridge Reservation and Nevada Test Site as alternative Spent Nuclear Fuel Management sites. Responded to comments of public and governmental agencies.

Analyst; Programmatic Tritium Supply and Recovery EIS; U.S. DOE; Washington, D.C.; Performed 10 CFR 100 dose limit analysis to determine the suitability of locating various tritium supply source designs and sizes at Oak Ridge Reservation, Pantex, and Nevada Test Site. Determined site capacity in accordance with regulation.

Analyst; Nonnuclear Consolidation EA, Nuclear Weapons Complex Reconfiguration Program; U.S. DOE; Kansas City, MO; Gathered data for chemical accident exposure analysis via site visit, interview with site personnel, personal inspection of facilities. Performed chemical accident analyses of existing and proposed chemical storage and operations facilities using CHEMS-PLUS (Chemical Hazard Evaluation Methodologies software package). Wrote environmental background sections.

Analyst; Estimated Frequency of Loss of Off-Site Power Due to Extremely Severe Weather and Severe Weather for Salem and Hope Creek Generating Stations; Public Service Electric & Gas; Salem, NJ; Determined frequency of occurrence of severe and extremely severe weather (snowfall, tornadoes, storms, hurricanes) and resulting frequency of off-site power loss to generating stations. A report which reported the results was produced and used by power company to successfully demonstrate to NRC, in accordance with Regulatory Guide 1.155, that special design and operating conditions limitations previously required by the commission were not necessary.

Analyst; Control Room x/Q Values for the Beaver Valley Power Station; Duquesne Light Co.; Pittsburgh, Pa; Performed theoretically advanced simulation of atmospheric dispersion in the presence of building wake turbulence for a 5 year sequential meteorological record. The results were included in a report which was used to successfully demonstrate to the Nuclear Regulatory Commission that special design implementations (filter systems) for station control room occupants, the necessity of which were indicated by previous analyses, were not required.

Analyst; Cooling Water Discharge Modeling; U.S. DOE; Savannah River; Developed thermal model of site streams between reactors (L, K, C, and power plant) and Savannah River (including swamp). Model used to predict downstream temperatures from cooling water discharges from various (combinations of) reactors, reactor operating levels, and discharge options. Model results were compared with subsequent operating data and demonstrated to be accurate. Developed associated models of cooling tower and cooling pond thermal performance (as a function of reactor operating condition and meteorology). Analyses used in various projects including design of alternative reactor cooling water systems, 316a demonstrations, L-Reactor restart, K-Reactor restart, and New Production Reactor cooling system design. Cooling pond model (L-Lake) used to study response of thermal discharge from lake to changing meteorological and reactor

operating conditions; also to study vertical thermal structure of lake and possible destratification in response to major changes in reactor operating levels. Various reports and EIS sections (and technical appendices) produced.

Analyst; Evaluation of Proposed 40 CFR 193, Subpart C; U.S. DOE, Office of Environmental Guidance; Washington, D.C.; Reviewed performance assessments and other supporting technical documents to proposed EPA rule on groundwater dose limits from low level radioactive waste disposal. Presented technical arguments showing that generic studies which formed the basis of the proposed rules were not appropriate for DOE sites. Report generated.

Analyst; V.C. Summer Station - Cooling Lake Thermal Performance; South Carolina Electric & Gas; Columbia, SC; Performed computer mathematical study of horizontal and vertical temperature distribution in a cooling lake to determine the likelihood of exceeding regulatory discharge limitations. The model simulated the cooling lake response to 30 years of historical meteorology, power plant (at various power levels) and pumped storage operation. The pumped storage reservoir's thermal response was also modeled. The results of the model were accepted by the state and an NPDES permit granted. An associated study to quantify the incremental (from power plant operation) evaporation from the cooling lake was used by the pumped storage operator to assess the power plant owners for the cost of makeup water and lost pumped storage energy caused by the plant's thermal discharge.,

Analyst; Internal Dose Reconstruction Model; Defense Nuclear Agency, Washington, DC; Developed a calculational model and associated computer code reconstructs internal doses resulting from inhalation and ingestion of radioactivity in a space and time varying contaminant field. The model was applied to participants at atmospheric tests of nuclear devices. These participants were moved through the radioactive field in accordance with the historical record; contamination from previous detonations were included.

Technical Manager; Environmental Survey Prioritization; U.S. DOE - Office of Environmental Audit; Washington, DC; Responsible for direction of multidisciplinary group which prioritized environmental problems at all U.S. DOE sites. Rankings used a health-based assessment of environmental transport of contaminants, including evaluation of source terms, environmental transport mechanisms, and human health effects and consideration of all environmental media (air, surface water and groundwater, soil, direct radiation). "Debugged," revised, and refined associated computer program, MEPAS. Developed technical guidance for developing conceptual models of environmental problems, applying the computer model, and interpreting results. Developed Risk Information System (RIS) which integrated various quantitative measures of environmental impact. Presented results to 5-Year Planning group for their use; critiqued their use of information. Presented results and responded to questions from congressional staff.

Analyst; Hazard Ranking System; U.S. EPA - Superfund Office; Washington, DC; Evaluated risk assessment methodologies in support of congressionally mandated revision to Hazard

Ranking System. Performed theoretical study and practical applications of models for use in comparative studies of mathematical models. Results of study used in selecting a more mechanistic methodology (modified HRS) for ranking the risk of hazardous waste sites.

Hydrologist; Various Projects; Industrial/Governmental Clients. Is responsible for analysis of physical effects due to transport of effluents into surface and groundwater environments. Responsibilities have included evaluation of effects from existing and proposed discharges at Milliken, Bell, Cayuga, and Somerset (New York State Electric and Gas Co.); Perry (Cleveland Electric and Illuminating Co.); Belvedere, Carrols Pond, Douglas Point, and Chalk Point (Potomac Electric Power Co.); Greenwood and Fermi (Detroit Edison Co.); Tyrone and Sherburne (Northern States Power Co.); Davis-Besse (Toledo Edison Co.); South Texas Project (Houston Lighting and Power Co.); Dresden, Powerton, La Salle, Braidwood, Byron, and Collins (Commonwealth Edison Co.); San Onofre (Southern California Edison Co.); Ginna, Russell, Beebee, and Sterling (Rochester Gas and Electric Co.); Palo Verde (Arizona Public Service Co.); Schuylkill Refinery (Gulf Oil Co.); Great Bend (Columbus and Southern Ohio Co.); Big Bend (Tampa Electric Co.); Rio Haina (Dominican Republic); Skagit-Hanford (Northwest Environmental Services Co.); Savannah River Plant (U.S. Department of Energy); Limerick (Philadelphia Electric Co.); V.C. Summer (South Carolina Electric and Gas Co.); uranium mill tailings sites (U.S. Department of Energy); deep geologic nuclear waste repositories (Office of Nuclear Waste Isolation); hazardous waste sites (U.S. Environmental Protection Agency); all of the defense production and support facilities of U.S. Department of Energy; Mallinkcrodt.

CHRONOLOGICAL WORK HISTORY:

Consultant; April 2004 to Present.

Engineer; Tetra Tech NUS, Inc.; Gaithersburg, Maryland; October 1971 to March 2004.

Teaching Assistant; University of Maryland; College Park, Maryland; September 1968 to June 1971. Taught both graduate and undergraduate courses, concerned with computer applications to chemical engineering. Conducted mathematical research on dynamics of nonlinear control systems.

Analyst; Kennedy Van Saun Corp.; New York, New York; June 1968 to September 1968. Conducted engineering analysis of solids separation systems.

PUBLICATIONS:

"An Example of the Public Risk Arising from the Accidental Contamination of Drinking Water by the Deposition of Airborne Radionuclides" (coauthor), Proceedings of International ANS/ENS Topical Meeting on Probabilistic Safety Methods and Applications, 1985.

"Higher Order Approximations to Unit Impulse Response," Master's Research Paper, University of Maryland, College Park, MD., January 1970.